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PATENT SPECIFICATION

DRAWINGS ATTACHED

1197,807

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COMPLETE SPECIFICATION

Tomato Juice Process

I, JOSEPH RICHARD WAGNER, a Citizen of the United States of America, of 26 Fieldbrook Place, Moraga, California, United States of America, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the preparation of tomato juice. More particularly, this invention relates to the preparation of tomato juice having a high consistency.

Consistency is measured by the method described below. For a gas or a simple (newtonian) liquid, consistency equals viscosity, but for a real fluid, including tomato juice, consistency differs from viscosity and it has no fixed relation to solids content. For example, two lots of tomato juice, prepared by different processes or from different types of tomatoes may have identical solids content but greatly different consistencies.

Except where otherwise stated, consistency is determined at 25°C. (77°F.) by measuring the time required for 96 ml. of the liquid to pass through 3.3 mm. internal diameter orifice of 100 mm. pipette. In terms of this test a longer flow time shows a higher consistency.

High consistency is a desirable property of tomato juice and of tomato juice derivatives such as concentrated tomato juice, tomato paste, sauces and ketchups.

In application No. 30775/66 (Serial No. 1,128,395) I have described a process of treating tomatoes to produce tomato juice of high consistency. This process involves adjustment of pH by adding acid to lower the pH to less than 3. Elsewhere I have suggested adding alkali to raise the pH to above 5 for the same purpose. The normal pH of tomato juice lies between these figures, typically about 3.8 and 4.2.

Tomato juice as ordinarily prepared undergoes rapid deterioration with regard to consistency. That is the consistency diminishes considerably very quickly after the raw tomatoes are macerated, i.e. after they have been broken up into a pulp which releases the juices from the skins and fibrous structure. It is believed that the release of enzymes and/or other constituents of the tomato which are separated from the juice in the whole tomato but are liberated when the tomato is macerated, cause reduction of consistency. Therefore, in accordance with the teachings of Application No. 30775/66 (Serial 1,128,395) the acid is added to the whole tomatoes before they are cut into pieces, or to large pieces of tomatoes before they have been macerated and the tomato structure has been disorganised and disrupted, or to the macerated pulp immediately after the maceration has been completed. Preferably, the acid is added to the whole tomatoes so that it is brought back into immediate contact with the pulp as it is formed.

As described in the aforesaid Application No. 30775/66 (Serial No. 1,128,395) the usual tomato processing techniques may be employed and the addition of acid is the only difference. This is an advantage because the progress does not require substantial changes in existing techniques. As also explained in Application No. 30775/66 (Serial No. 1,128,395), either the cold-break or hot-break method may be used. In the cold-break method raw tomatoes are macerated at ambient (room) temperature and the resulting pulp is pressed through perforated sheet metal or wire mesh screens to separate the juice from the seeds, skins and cores. It is common to heat the juice after it has been separated in order to inactivate enzymes. In the hot-break method the same mechanical steps are used but heat is applied during maceration, i.e. the tomatoes,

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during maceration or immediately after they are broken up—are quickly heated to a temperature of 185°F. or higher to inactivate the enzymes responsible for the loss of consistency. As also explained in Application No. 30775/66 (Serial No. 1,128,395) the acid treated tomato juice is adjusted in pH back, or nearly, to its normal value, e.g. about 3.8 or 4.2, because acid treated tomato juice having a pH of 3 or less is excessively sour.

As also described in Application No. 30775/66 (Serial No. 1,128,395) any non-toxic acid may be used which will produce a pH of less than 3. Suitable acids are hydrochloric, sulphuric acid and phosphoric acid. Hydrochloric acid is advantageous because, upon addition of sodium hydroxide to restore the normal pH, sodium chloride (which is a common constituent of foods) is formed. Suitable alkalis are sodium hydroxide, potassium hydroxide, sodium carbonate, potassium carbonate. Sodium hydroxide is advantageous because on adding hydrogen chloride to restore the normal pH sodium chloride is formed.

In prior Application No. 30775/66 (Serial No. 1,128,395) the pH is reduced to less than 3 but preferably not below about 2 because a lower pH does not produce any improvement in consistency and it requires more acid and also more alkali to restore the pH. Also a more highly acid juice is more corrosive to equipment.

I have now found that in the acid treatment procedure as applied to the hot-break method a pH as high as 3.5 may be used, and that certain advantages are obtained by adding the acid, not to the raw tomatoes, but to tomato material which previously has been subjected to heating to inactivate enzymes. One advantage of this modification is that it presents a lesser possibility of corrosion of equipment. This follows because the heating to achieve enzyme inactivation is carried out at the natural pH, in contrast to the previous system wherein such heating is applied at the low pH generated by the added acid. Another advantage lies in lower power consumption which is explained as follows. In the previously-mentioned process, increase in consistency takes place as the acidified raw tomatoes are macerated whereby considerable resistance to the macerating action develops. In the acidification just described the increase in consistency is delayed until the steps of maceration and heating have been completed with the net result that the power required for the maceration step is less. This modification does not produce as high a consistency as the procedure in which tomatoes are acidified and are heated in acidified condition but it does improve consistency very substantially compared with conventional procedures. Also the yield of tomato juice is substantially higher than with conventional procedures, e.g. 1 to 2% higher.

According to the present invention, therefore, a process for producing tomato juice of high consistency comprises:

- a) heating raw tomatoes, at their natural pH, at a temperature and for a time sufficient to inactivate the enzymes, but insufficient to damage the tomatoes;
- b) mixing the resulting tomato material with an amount of non-toxic acid sufficient to provide a pH of 3.5 or less; and
- c) extracting the juice from the resulting mixture.

Raw tomatoes, at their natural pH, are subjected to heating to inactivate the enzymes. This heating can be accomplished in various ways as well known in the art. One technique involves exposing whole tomatoes or pieces of tomatoes to steam or a source of radiant energy such as infra-red lamps or a microwave irradiation device. Preferably, the tomatoes are heated while concomitantly subjected to maceration. (The term "maceration" is employed herein—in common with its usage in the art—to denote application of mechanical action to break up and sub-divide the tomatoes into a pulpy mass). To achieve such an end one may utilise the usual heating and macerating procedure as conventional in producing tomato juice by the hot-break system. Thus, raw tomatoes are fed into a vessel provided with steam coils (or steam jackets) and a rotating blade assembly for comminuting the tomatoes and agitating the material in the vessel so that good heat transfer will be obtained. By use of such equipment the raw tomatoes can be efficiently formed into a hot macerate which is ready for the next step. In cases where it is desired to achieve an especially rapid heating, one may employ a "drop-in" technique. This involves establishing a pool of tomato juice or tomato macerate (from a previous batch) in a vessel equipped with heating means and a rotor for comminuting and mixing the contents of the vessel. The pool of juice is maintained at about 200°F. and the tomatoes are fed into it at a predetermined rate. Because of the intimate contact with the hot juice, the entering tomato material is very rapidly brought up to an enzyme-inactivating temperature. The hot macerate produced in the vessel is withdrawn at a rate commensurate with the feed rate and this hot material is forwarded to the next step in the procedure. Various other examples of systems for effecting the heating—or the concomitant heating and macerating—will be suggested to those skilled in the art from the above description. It is further obvious that regardless of the particular system used, the temperature and time of heating applied to the tomatoes must be sufficient to inactivate the enzymes. It is equally obvious that the programme of heating must not be so drastic as to damage the tomato material.

After the tomatoes have been treated to in-

activate the enzymes, the resulting tomato material—preferably in the form of a macerate—is mixed with an acid. The acid treatment is carried out as described above, i.e. it may be carried out at a pH of 2 or 3 as in prior Application No. 30775/66 (Serial No. 1,128,395) or it may be carried out at pH of 3 to 3.5. Either form of acid treatment causes an increase in consistency of the tomato material. The mechanism for this action has not been firmly established. However, it is believed that the addition of the acid causes an increased extraction or transfer of pectinous material from the cellular particles to the liquid (serum) part of the tomato material, so that the material as a whole becomes thicker, i.e. higher in consistency.

It is preferred to apply the acid to the tomato material in its hot condition (usually about 185—212°F) as it is received from the previous enzyme-inactivation step. Application of the acid to the hot tomato material facilitates uniform blending of the acid with the tomato material so that the desired consistency increase is attained rapidly. It is obvious that if the tomato material is not in comminuted form when the acid is applied, the mixture of acid and tomato material is subjected to the action of conventional equipment to obtain a macerating action, thus to attain a good contact between the acid and the tomato particles.

After the tomato material has been heated and then treated with acid as described, it may be treated as described above or as described in Application No. 30775/66 Serial No. 1,128,395.

The present invention can be applied to conventional juice production lines with but minor changes. Thus, standard juice production by the hot-break method involves a first stage where the tomatoes are macerated and heated to an enzyme-inactivating temperature (usually at least 185°F). In a second stage the hot macerate is treated to separate the juice from the seeds, skins and other fibrous material. In accordance with the invention, one may add to such a line (a) a first mixing device for incorporating acid with the hot macerate and (b) a second mixing device for neutralising the acidified material before it goes to the juice extractor. It may be noted that such changes in the standard production pattern do not contribute any interference with flow of the tomato material through the system. Thus, addition of the acid does not interfere with or prolong the heating/macerating step and the neutralisation step likewise does not cause any delay in transferring the pulpy mass to the juice extracting step. A typical adaption of a standard continuous juice production line to operate in accordance with the process of the invention is illustrated in the flow sheet in the drawing annexed hereto.

Referring to the flow sheet, raw tomatoes

are continuously fed at a predetermined rate into macerator 1. Therein, the tomatoes are rapidly comminuted and concomitantly heated to about 200°F. The resulting hot macerate flows to mixer 2 together with a flow of acid metered to provide the proper pH. During mixing of the macerate and acid, the consistency is increased as above described. The acidified material then flows to mixer 3 wherein it is blended with a stream of sodium hydroxide solution metered to restore the macerate to its natural pH level. The neutralised macerate is then directed to screw press 4 to separate the juice from the skins, seeds etc. The juice issuing from the screw press may be then processed in known manner to produce canned juice, concentrated or dehydrated products, etc.

Tomato juice prepared in accordance with the invention may be processed in conventional manner. For example, it may be canned as a single strength juice or it may be first concentrated to a paste or puree and canned in such state. It may be used, in single strength or concentrated form, in the preparation of soups, sauces, ketchups, preserves, aspic products etc. Also it may be converted into solid dehydrated products by such known techniques as concentration followed by foam-mat or vacuum dehydration or by spray drying. It is an important feature of the invention that the colour, flavour, and nutrient value of the juice are not impaired so that it is suitable for all the uses for which conventional tomato juice is adapted.

Since the process of the invention produces a high-consistency juice, this product can be blended with conventional juices, (ones of lower consistency) to provide a composite juice of intermediate consistency as may be required for a particular application. As an example of such procedure, a juice processing line may be operated for a first period in conventional manner and operated for a second period with application of the process of the invention, the two juices being then combined to yield the final product. By varying the relative duration of the first and second periods, products of a wide range of consistency can be produced.

The following Example illustrates the invention.

EXAMPLE

In these runs, the starting material was heated by a "drop-in" technique to attain rapid inactivation of enzymes. Thus, a heated (200°F.) pool of tomato juice was provided to serve as a direct-contact heating medium. Tomatoes were fed into this pool in portions, while applying macerating action and heating to maintain the system at 200°F. Because of the intimate contact with the hot juice, the entering tomato material was very rapidly brought up to the desired temperature. More particulars of the procedure used are given below:

The runs were carried out employing a large "Waring Blender" equipped with a 1 gallon bowl and a rotating blade assembly in the base of the bowl to cut and blend the material contained therein. A steam coil was also provided for heating the material in the bowl.

At the beginning of each run, 500 grams of previously-prepared tomato juice was placed in the blender and heated to 200°F. and maintained in the range of 190—200°F. throughout the run while rotating the blade continuously.

A 1 kg. lot of fresh tomatoes (cut into quarters) was divided into four portions and these portions were fed into the hot juice at about 15 second intervals. At about 2 minutes from the start of the run, heating was discontinued (by removing the steam coil from the bowl) but operation of the blade was continued

to complete breakdown of any fragments of intact issue. At this point, a hydrochloric acid was added to the macerate in an amount to provide a particular pH (as specified below).

After the acid was blended into the macerate (approximately 4 minutes from the start of the run), the macerate was put through a pulper to separate the juice from the skins, seeds, etc. and the juice was cooled. It was then tested for pH and consistency. (In one run, no acid was used, thus to provide a control).

The juice used as the heated liquid for the runs was conventional juice. It was prepared by macerating raw tomatoes at their natural pH without any additives, heating to destroy enzymes, and extraction of the juice from the macerate with a conventional pulper.

The results are tabulated below:

Run	Acid added	pH	Consistency of juice* seconds
1 (control)	None	4.48	30.3
2	HCl	3.10	43.3
3	do.	2.52	58.5
4	do.	1.47	63.7

*Consistency was determined at 25°C. by measuring the time required for 200 ml. of the juice to pass through the 0.125 inch (I.D.) orifice of a 260 ml. pipette.

WHAT I CLAIM IS:—

1. A process for preparing tomato juice of high consistency which comprises:

(a) heating raw tomatoes, at their natural pH, at a temperature and for a time sufficient to inactivate the enzymes, but insufficient to damage the tomatoes;

(b) mixing the resulting tomato material with an amount of non-toxic acid sufficient to provide a pH of 3.5 or less; and

(c) extracting the juice from the resulting mixture.

2. A process according to claim 1 wherein the acid is hydrochloric acid.

3. A process according to claim 1 or 2 wherein the acid is present in an amount to provide a pH of 2.5 to 3.

4. A process according to any of claims 1 to 3 wherein the raw tomatoes are macerated concomitantly with the heating of step (a).

5. A process according to any of claims 1 to 4 wherein the acidified tomato material re-

sulting from step (b) is neutralised to its natural pH by addition of non-toxic alkaline material, prior to extraction of the juice therefrom.

6. A process according to any of claims 1 to 4, wherein the juice from step (c) is neutralised to its natural pH by addition of a non-toxic alkaline material.

7. A process according to claim 1 substantially as described in the Example.

8. A process for preparing tomato juice of high consistency according to claim 1 substantially as hereinbefore described.

9. Tomato juice of high or increased consistency whenever prepared by a process of any preceding claim.

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